PERFORMANCE OF RECIPROCAL CROSSES IN CORN

BY

LOYAL FREDERICK BAUMAN

B.S., University of Illinois, 1946
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY
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ACKNOWLEDGMENT

The writer wishes to express his sincere appreciation to Doctor C. M. Woodworth, his chief advisor, for advice and encouragement given during this study. Gratitude is also expressed to Doctor Woodworth for his careful reading of the manuscript.

The writer also wishes to express his sincere thanks to Doctor R. W. Jugenheimer for his valuable suggestions and assistance.

PERFORMANCE OF RECIPROCAL CROSSES IN CORN

Since experimenters have begun the hybridization of corn, the question has frequently arisen whether reciprocal crosses are equal in performance. Despite the importance of such differences and reports by several workers of inequality in performance of reciprocals, little attention has been given to this problem. The objective of the studies reported in this paper was to determine if various types of reciprocal crosses are equal in performance and, if possible, to ascertain the cause of such differences. Characteristics considered in this investigation included early plant vigor, silking date, plant and ear height, kernel row number, ear length, lodging and yield.

Material and Methods

Reciprocals of single crosses, variety crosses and backcrosses were tested in 1948 and 1949. In addition, the F_2 generations of a number of reciprocals were tested in 1949. Single crosses included a systematic set of 21 crosses involving seven inbreds. Crossed seed was produced in paired rows and seed from plants on one side of the cross was composited. Seed for the F_2 generations was obtained by selfing at least two F_1 plants of the reciprocals.

The material was tested in a randomized block with split plot so that the reciprocals of a particular cross appeared side by side in the field. This eliminated a large amount of environmental variation. Analysis of variance procedure was used to establish significance of inequalities between reciprocals. Plots were planted at a heavy rate and later thinned to three plants per hill to obviate differences in performance that might be caused by unequal plant populations. Seed was not chemically treated.

Experimental Results

Miscellaneous Reciprocal Crosses:

Among 24 reciprocal F_1's and 11 F_2's of reciprocals, 54

percent and 45 percent, respectively, exhibited differences in performance. Inequalities were noted for silking date, plant and ear height, kernel row number, ear length, erect plants, and yield. Some reciprocals differed in more than one characteristic. The material tested was not, however, a random sample, as selection of some entries for testing in 1949 was based on observations during the 1948 season or known differences in seed quality. An interesting observation among the miscellaneous crosses tested was that none of the inequalities in F_2 corresponded to similar significant differences in their F_1's. There were actually two instances where significant reversals occurred in performance of the F_1's and their F_2's.

Reciprocals of several crosses (K201 × 38-11, K201 × Oh7, and Os420 × 187-2) exhibited large differences in early plant vigor and these were maintained to maturity as shown by plant and ear heights. However, these inequalities in F_1 did not carry through into the F_2 generations. It appears possible that, because of differences in early plant vigor, and failure of similar differences to appear in F_2, these inequalities for plant and ear height may be due to differences in seed quality of sufficient magnitude to affect mature plant characteristics.

Reciprocal Systematic Single Cross Set:

A systematic single cross set tested in 1948 involved the following inbreds: A, 90, R4, 187-2, WF9, L289, and W8. This gave a total of 21 single crosses, or 42 including reciprocals. The performance of reciprocals was remarkably similar in most cases. However, two definite exceptions were noted. A × 187-2 outyielded its recriprocal by 7.4 bushels. The other exception was WF9 × 90 which exhibited lower plant and ear height, shorter ear length, and lower yield than 90 × WF9. Examination of WF9 × 90 ears at harvest revealed that 12 percent had only 50 percent seed set. Cytological examination revealed that a translocation was involved. It is evident that presence of plants with only 50 percent seed set reduced yield, but the translocation perhaps also affected plant vigor, reducing plant and ear height, and ear length.

Average performance of the seven inbreds as male and female parents in combination with the other inbreds in the systematic set was in very close agreement. On basic of results from this systematic set, it may be concluded that average performance of lines used as ear or pollen parents in crosses is not differentially affected.

Reciprocal Backcrosses:

Inbred R30, a white endosperm line, was crossed reciprocally with three yellow lines 187-2, Hy2, and WF9. The reciprocal single crosses were then backcrossed reciprocally to the yellow parent, giving four backcrosses in each case. Theoretically, the four backcrosses should be genetically equal.

Backcrosses involving 187-2 with R30, differed in yield. Backcross (R30 × 187-2)187-2 yielded significantly less than 187-2(187-2 × R30) or than (187-2 × R30)187-2. Among all backcrosses of R30 with these three yellow lines, the lower yielding backcrosses always had R30 as the female parent in the original single cross. Mean yield of the six backcrosses with R30 as seed parent was 64.1 bushels and that of six backcrosses with R30 as male parent was 69.1 bushels.

Among backcrosses involving WF9 with R30, all four backcrosses differed significantly in ear length. The two backcrosses produced on inbred WF9 were shorter eared than those produced on the single cross seed parent. Of the two backcrosses produced on inbred WF9, the one with R30 as seed parent in the original single cross was the shorter eared. This was also true of the two backcrosses produced on single cross seed parents. Again, as with yield, the use of R30 as seed parent in the original cross tended to produce shorter eared backcrosses than as pollen parents. Mean ear lengths of the six backcrosses with R30 as seed parent was 7.30 inches, and mean ear lengths of the six with R30 as male was 7.52 inches.

Genetic differences, if existent, were likely present in the original single crosses because the two reciprocal backcrosses involving the same single cross, as 187-2(R30 × 187-2) and

(R30 × 187-2)187-2, did not differ greatly. The differences were between backcrosses involving different reciprocal single crosses.

Reciprocal Crosses Among Illinois Chemical Strains:

Reciprocals among high oil, low oil, high protein, and low protein strains of corn exhibited inequalities in early plant vigor, silking date, plant and ear height, kernel row number, ear length, and yield. These strains possess a considerable degree of heterozygosity and heterogeneity. Therefore, some of these inequalities perhaps arose from genetic variation, owing to the fact that different plants were used as males and females in making up the crosses.

The chemical strains differ greatly in seed quality. High oil gives superior early plant vigor when used as seed parent. High oil × low protein, high oil × low oil, and high protein × low oil exhibited greater early plant vigor and silked earlier than their reciprocals. The advantage in early plant vigor was not maintained to maturity. In all these three crosses, the cross that exhibited the greater early plant heights gave lower plant and ear heights at maturity, compared to their reciprocals.

Discussion and Conclusions

Evidence was presented that reciprocal F_1's, backcrosses, and F_2's of reciprocals may differ in performance in early plant vigor, silking date, plant and ear height, kernel row number, erect plants, and yield. Most inequalities were not of general occurrence and were not consistent, i.e., an inbred did not always show reciprocal differences in crosses with several inbreds. F_2 differences did not necessarily correspond with similar differences in their F_1's.

Large reciprocal differences in early plant vigor, due to seed quality, were perhaps of sufficient magnitude to affect mature plant characteristics as plant and ear heights and perhaps ear length and yield.

Some reciprocal inequalities were due to genetic differences which arose from heterozygosity or heterogeneity of one or both parents. F_2 inequalities were probably due to genetic variation between or within the F_1's. Two F_1 plants were selfed to obtain F_2 seed, and such a small sample could not adequately represent the F_1 populations if they were heterogeneous.

Little or no evidence was presented to indicate that cytoplasmic inheritance was involved in causing reciprocal differences. Seed quality, genetic differences and; or a combination of the two appeared to be primarily responsible for reciprocal inequalities noted here.

VITA

The author was born on a farm near Nokomis, Illinois, on October 18, 1920. He attended rural school there, and in 1938 was graduated from the Nokomis Township High School. He then completed one year of high school post-graduate training.

He entered the University of Illinois in the fall of 1940, majoring in general agriculture. Undergraduate study was continued until February, 1943, at which time he enlisted in the Army Air Force.

In the Air Force he completed pilot training and served as an instructor in advanced flight training and in an administrative position until his discharge from service in October, 1945.

He immediately resumed his undergraduate training, receiving the degree of Bachelor of Science in Agriculture in June, 1946. He then entered graduate training at the University of Illinois, majoring in plant genetics, and received his Master of Science in Agronomy in October, 1947. In September, 1946, he was appointed a Special Research Assistant in Plant Genetics in the Department of Agronomy, Illinois Agricultural Experiment Station, being associated with the corn greeding project.

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Publication: With R. W. Jugenheimer, D. E. Alexander, and C. M. Woodworth. Experimental Corn Hybrid Tests in 1949. Ill. Agr. Expt. Sta. Bull. 538. 1950.